

CAPSELA[®] SCIENCE BOOKLET

See how it works!

BY DR. CLIFFORD SWARTZ



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CONTENTS

DR. CLIFFORD SWARTZ'S STATEMENT

PRODUCT GUIDE

SCIENCE CONCEPTS

CAPSELA GEAR CAPSULE DESCRIPTIONS

PROJECT 1—ENERGY CHANGES

PROJECT 2—ELECTRIC CIRCUITS

PROJECT 3—MOTION ENERGY

PROJECT 4—GEARS: SPEED AND TORQUE

PROJECT 5—FRICTION AND TRACTION

PROJECT 6—CHAIN DRIVE

PROJECT 7—INCLINED PLANE

PROJECT 8—THE CROWN GEAR

PROJECT 9—THE ELECTRICAL SWITCH BOX

PROJECT 10—BUOYANCY

PROJECT 11—ELECTRIC CIRCUITRY

PROJECT 12—FORCE

PROJECT 13—TRANSFORMATION OF ENERGY

PROJECT 14—VACUUM

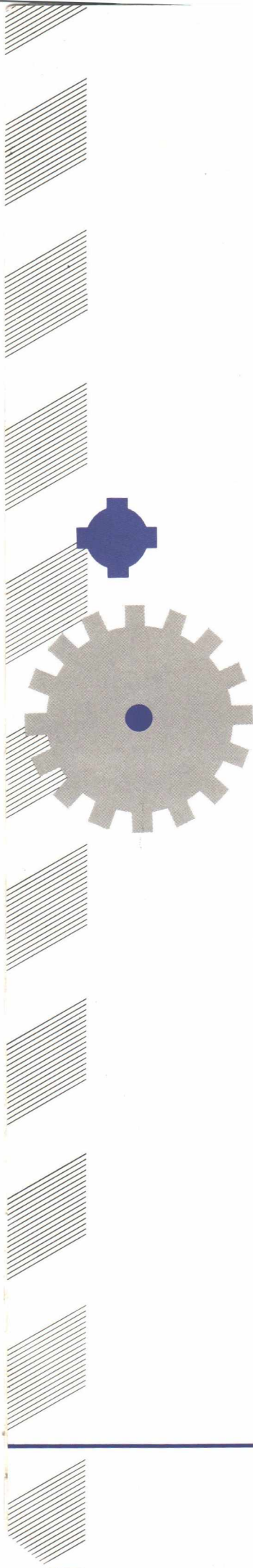
PROJECT 15—WHEEL AND AXLE

PROJECT 16—NEWTON'S THIRD LAW

PROJECT 17—FRICTION

PROJECT 18—SCIENCE OF THE PROPELLER CAR

SEE HOW IT WORKS



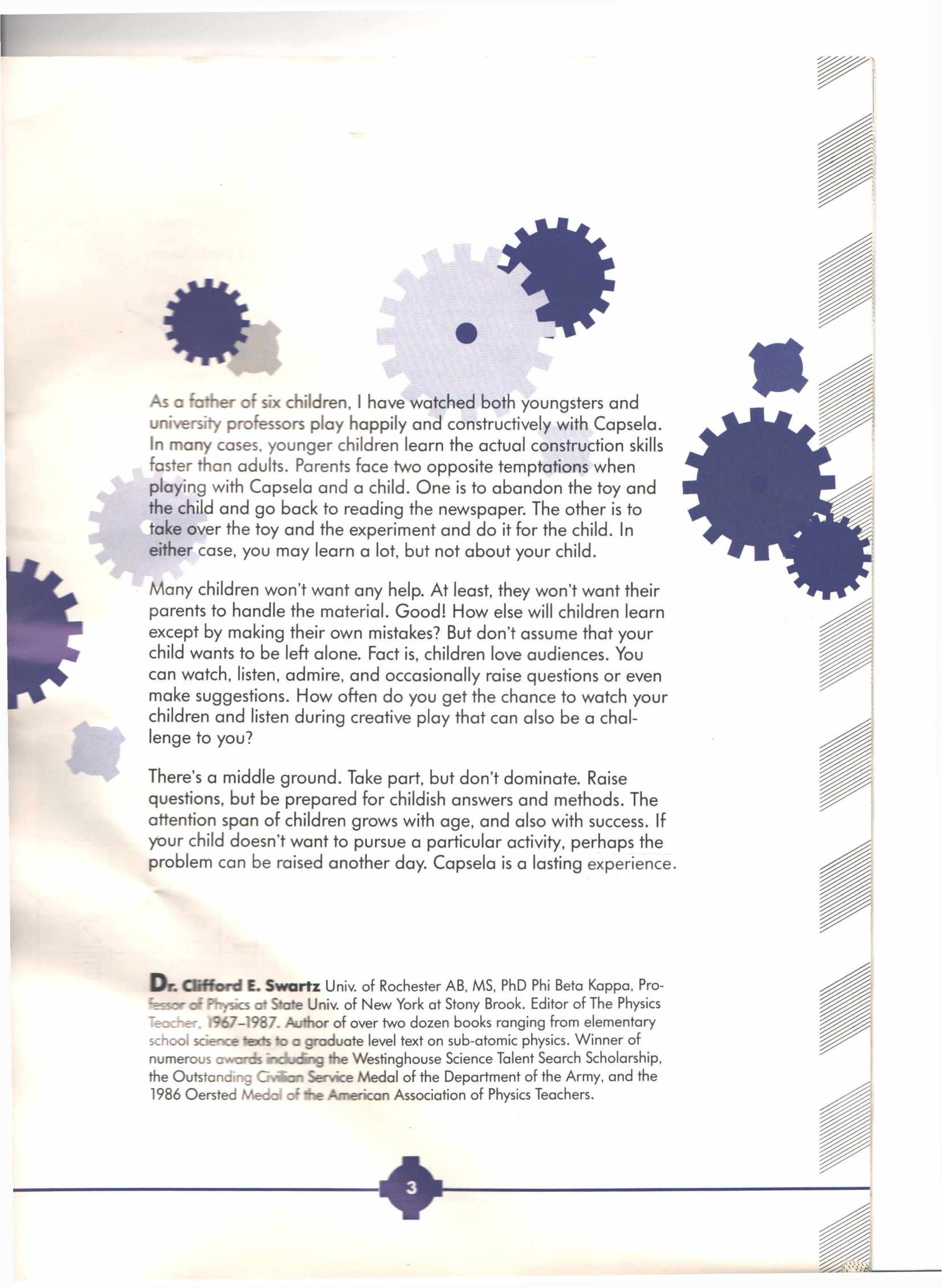
SEE HOW IT WORKS!

Science Booklet by Dr. Clifford Swartz

Capsela® is a wonderful toy, and it can also be a valuable learning tool. When children have fun while learning, it makes the learning process easier. It is also true that learning a few scientific principles and skills will creatively make playing with Capsela a lot more fun. Best of all, these principles and skills are very basic, important in school science studies.

The Capsela® Science Discovery Motorized system provides youngsters with "hands-on" experiences. Instead of just reading about energy or forces, they can actually handle batteries and motors and see for themselves how energy changes with the help of visible gears and wheels. All this material can be studied and used by children of all abilities and ages from about seven years up.

In the following pages we suggest a series of activities. In each case we give some of the background science and describe how to do each activity. Perhaps older children can read the explanations themselves. However, younger children may need your help not only in reading but also in construction. Everyone can enjoy the discussions and learning together.

The page is decorated with several dark blue gears of various sizes. A vertical bar on the right side features a series of parallel diagonal lines. The background has a subtle, light-colored pattern.

As a father of six children, I have watched both youngsters and university professors play happily and constructively with Capsela. In many cases, younger children learn the actual construction skills faster than adults. Parents face two opposite temptations when playing with Capsela and a child. One is to abandon the toy and the child and go back to reading the newspaper. The other is to take over the toy and the experiment and do it for the child. In either case, you may learn a lot, but not about your child.

Many children won't want any help. At least, they won't want their parents to handle the material. Good! How else will children learn except by making their own mistakes? But don't assume that your child wants to be left alone. Fact is, children love audiences. You can watch, listen, admire, and occasionally raise questions or even make suggestions. How often do you get the chance to watch your children and listen during creative play that can also be a challenge to you?

There's a middle ground. Take part, but don't dominate. Raise questions, but be prepared for childish answers and methods. The attention span of children grows with age, and also with success. If your child doesn't want to pursue a particular activity, perhaps the problem can be raised another day. Capsela is a lasting experience.

Dr. Clifford E. Swartz Univ. of Rochester AB, MS, PhD Phi Beta Kappa, Professor of Physics at State Univ. of New York at Stony Brook. Editor of *The Physics Teacher*, 1967–1987. Author of over two dozen books ranging from elementary school science texts to a graduate level text on sub-atomic physics. Winner of numerous awards including the Westinghouse Science Talent Search Scholarship, the Outstanding Civilian Service Medal of the Department of the Army, and the 1986 Oersted Medal of the American Association of Physics Teachers.

CAPSELA SYSTEM PRODUCT GUIDE



#200 STARTER SET

Build 10 land models. Contains 36 parts. Learn 6 science principles.



#250 EXPLORER SET

Build 20 land models and introduces chain drive. Contains 42 parts. Learn 7 science principles.



#450 DISCOVERY SET

Build 30 action models including a unique slow moving robot. Contains 85 parts plus chain links. Learn 9 science principles.



#400 INTERMEDIATE SET

Build 22 land and water mechanized models. Contains 48 parts including flotation pods. Learn 9 science principles.



#500 ADVANCED SET

Build 39 land and water complex models. Contains 72 parts, introducing a blinking light source and variable speed control. Learn 14 science principles.



#700 DELUXE SET

Build 56 unique land and water machines and models. Contains 90 parts, including a water pump and vacuum device. Learn 17 science principles.



#1000 EXPERT SET

Build 100 advanced land and water models and powerful complex machines. Contains 108 parts plus chain-links...the entire range of components. Learn 18 science principles.

Spare parts can be obtained from: **PLAY-JOUR Inc.**

200 Fifth Avenue

Suite 1024

New York, NY 10010

SERIES	PROJECT																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
200																		
250																		
400																		
450																		
500																		
700																		
1000																		

SCIENTIFIC CONCEPTS

Force: A force is a push or a pull. Forces can be felt or exerted with fingers, and can be measured by stretching spring scales.

Work: To perform work you must exert a force through a distance. Work is something you do or a machine does.

Energy: Work can be transformed into stored energy. Various forms of energy can be transformed into each other—electrical, chemical, gravitational, motion, heat.

Momentum: The product of mass and velocity.

Machines: Levers, inclined planes, wheel-and-axles, and pulleys are simple machines. Machines transform work or energy from one form to another. Machines allow an exchange of greater force output for shorter distances traveled, or less force for greater distance. Similarly, they allow greater torque at smaller rotational speed, or smaller torque at higher speed. Machines can also make the direction of the output force or torque different from the input force or torque. Energy output from a machine is always equal to or less than the energy input.

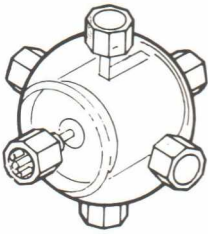
Electricity: Electricity can flow only through a closed path (or circuit). Electricity can flow in one direction or the other in a wire, depending on the way the ends of the wire are connected to the battery. The direction of the electric current in an ordinary light bulb makes no difference in the amount of light produced. However, some motors will reverse their direction if the current is reversed. Two batteries in series provide more voltage and thus more energy than one single cell.

Fluids—Archimedes' Principle: An object in water is buoyed (or pushed up) by a force equal to the weight of the water displaced. Therefore, an object will float if it weighs less than water having the same volume.

Newton's Third Law: If one object exerts a force on a second one, the second one exerts an equal and opposite force on the first one.

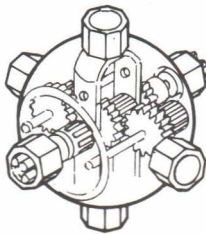
CAPSELA GEAR CAPSULE DESCRIPTIONS

1. Motor Capsule



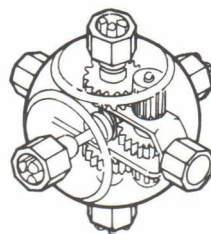
- Power Source to motorize all models
- Activated by AA battery
- 9600 RPM Speed

2. Speed Reduction Capsule



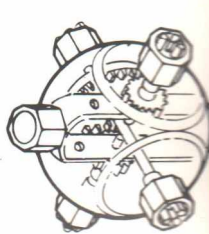
- Reduces Motor Speed (Ratio 23:1) but increases the torque or turning power

3. Worm Gear Capsule



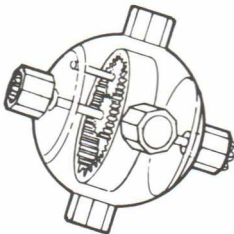
- Combines function of speed reduction and crown wheel capsules into a single unit. Decrease RPM ratio to 48:1.

4. Crown Wheel Capsule



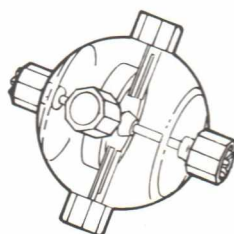
- Changes direction of motive drive through a 90 degree angle. Decreases the RPM ratio 2:1

5. Internal Gear Capsule



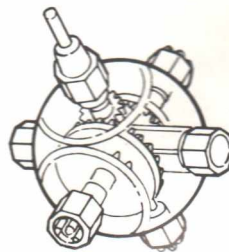
- Changes Shaft Speed (increases or decreases RPM ratio 3:1) without changing direction of motive drive

6. Rotary Switch Capsule



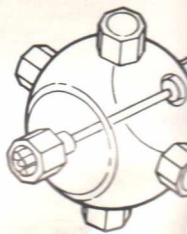
- As shaft turns switch is opened and closed activating blinking light function

7. Clutch Capsule

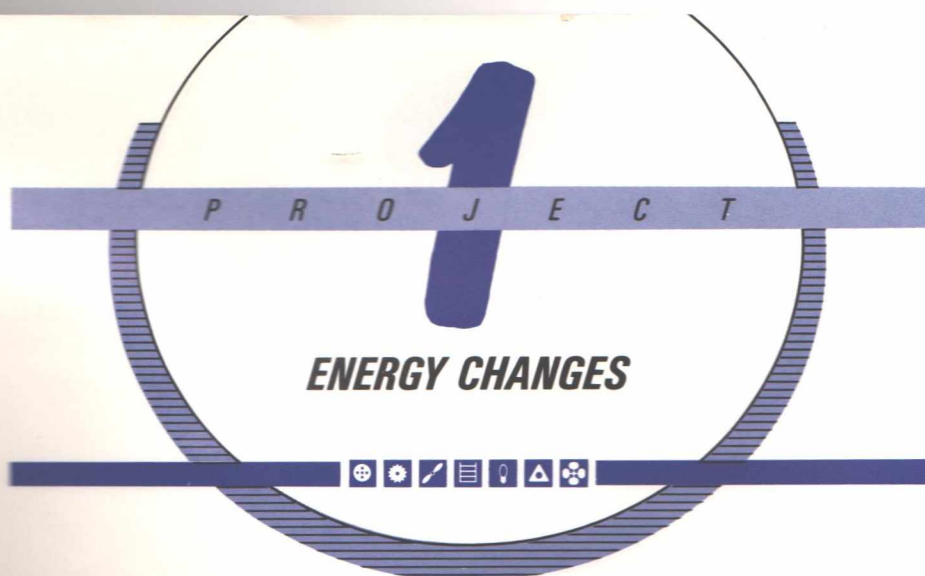


- Designed to engage or disengage motor drive allowing two separate individual actions on same model
- Double clutching mechanism

8. Transmission Capsule

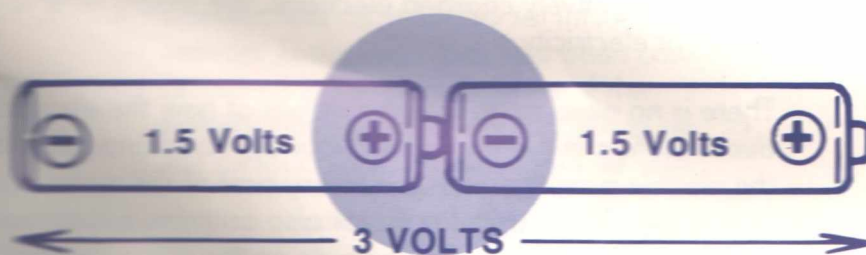


- Extends gear action without changing connecting gear motive force

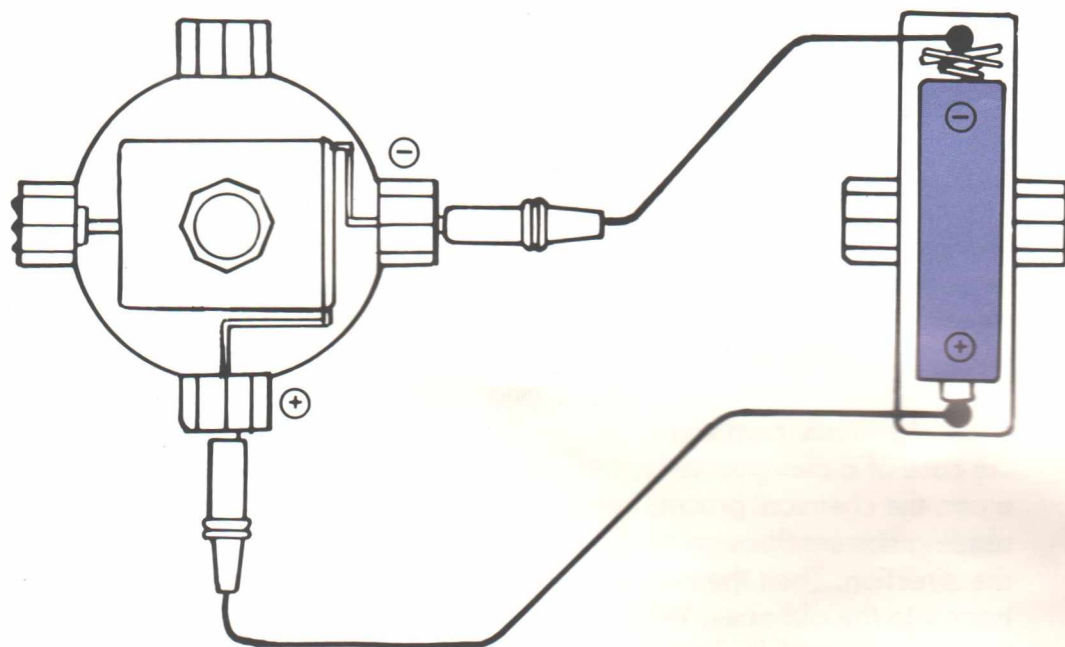


The most basic fact about energy is that it can be changed from one kind to another. Capsela can show these changes. In the beginning there is chemical energy in any electrical battery but it turns into electric energy as current is produced. The chemicals inside the battery change into other chemicals, containing less stored energy. In the case of a chargeable battery, such as that in a car, the chemical process can be reversed by sending current through the battery in the opposite direction. Then the new chemicals change back into the old ones. With ordinary "dry cells," like those in small flashlights, the process is irreversible. When the chemicals have all been changed into others, the battery is dead.

Technically, a "battery" is a collection of single "cells," usually wired in series (+ end of one connected to the - end of the next) so that their voltages add up. The usual dry cell produces 1.5 volts. Two in series yield 3 volts. The cell in a car storage battery produces 2 volts. Most car batteries consist of six of these cells in series, producing 12 volts. Generally, the word "battery" is used even if there is only one cell.

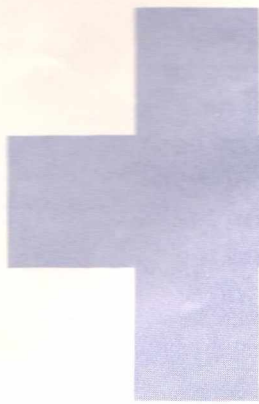


ELECTRIC CIRCUITS



The electric current, and thus the energy, is carried by wires. Technically, electric current in ordinary wires is produced by the movement of negatively charged electrons. We simply refer to this as the “flow” of electricity.

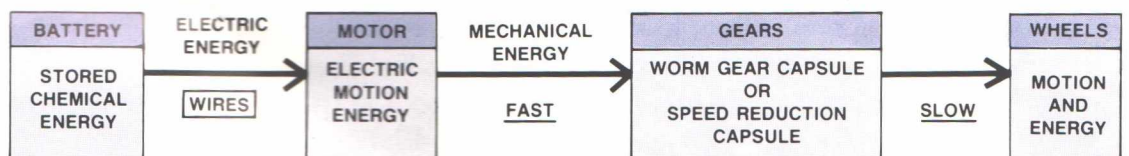
There is no need to go into the details of how the electricity produces motion in the motor. For your own background information, the electric current makes the rotary part of the motor into an electromagnet. This particular motor also contains a stationary permanent magnet, which pushes or pulls on the rotary magnet. Because the direction (north-south) of an electromagnet depends on the direction of the current, the direction of the motor spin reverses if the current is reversed. Suggest that your child try reversing the leads from battery to motor and observe that the motor spins in the opposite direction.



Energy flows from the battery to the motor and then to the wheels or propeller. It changes from chemical energy into electric energy and then into motion energy. Resistance in the wires and friction in the moving parts turn part of the energy into waste heat. In some devices you can feel the temperature increase as this happens. (Just rub your hands together briskly, and the skin will get hot from the friction.)



After a lot of use the battery will be dead. Its useful stored chemical energy is gone, and the motor and wheels will no longer have motion energy. Where did the energy go? All the wires and moving parts were made slightly warmer. The air was also set into motion. The energy that had been concentrated in the small volume of the battery has now been spread out to all the surroundings, making them warmer.

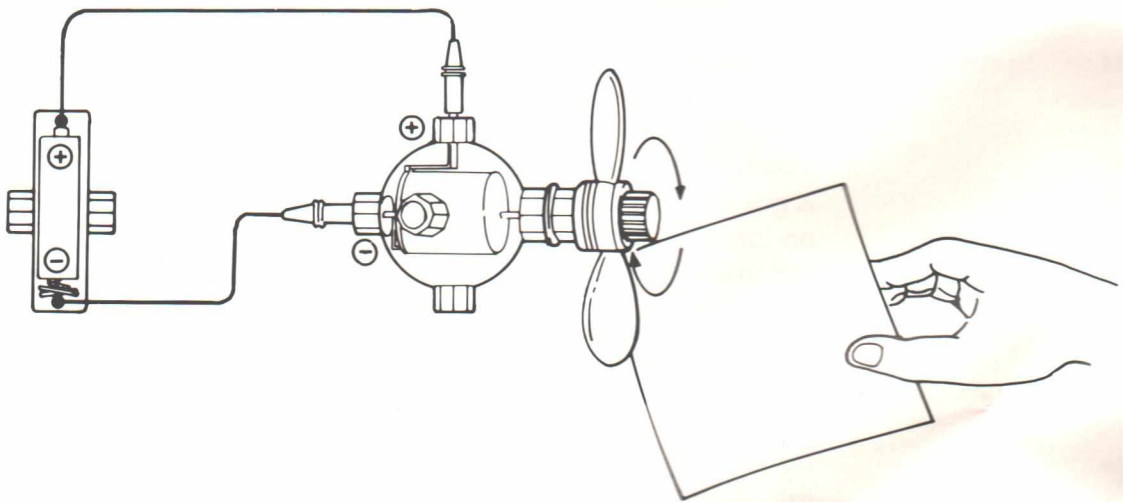


GEARS: SPEED AND TORQUE

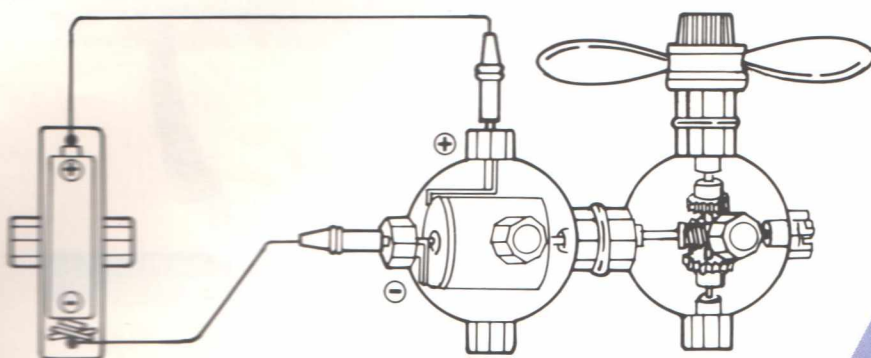


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The motor spins very rapidly. You can see the effect by fastening the propeller directly on the motor shaft. The propeller spinning at high speed makes an excellent fan because it pushes a lot of air. However, the propeller can't exert much turning force. You can easily stall it by forcing it to beat against an ordinary sheet of paper. If you could connect the motor directly to the wheels on the car, the wheels would turn rapidly until they tried to move the car and the motor would stall, because they don't have enough turning force. This "turning force" is called torque.

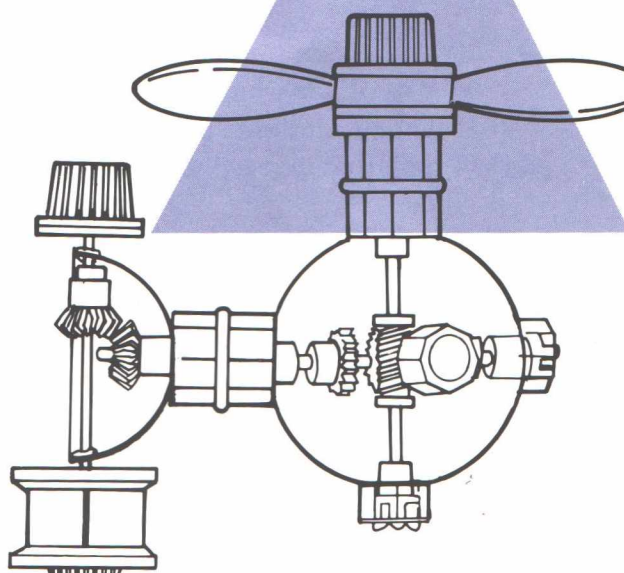


In order to increase the torque to move the car, you must use gears. The worm gear capsule not only slows the speed, and increases the torque, but it also changes the direction of the drive by 90°. Also, the speed decreases by a ratio of 48:1.



You can see the gears slow down the speed by actually measuring the "reduction ratio." Fasten the propeller on the gray end of the worm gear capsule. Fasten a wheel on the driven end which will be perpendicular to the propeller. Mark one point on the rim of the wheel. How many turns of the propeller does it take to cause one turn of the wheel? This is the reduction ratio of the worm gear. You will find that you must turn the propeller 48 times in order to make the wheel go around once.

You can see how much the worm gear increases the torque by mounting the propeller on its output. Connect the motor to the gray input of the worm gear. The propeller now turns much more slowly—by a factor of 48—than it did when fastened directly to the motor, but it has much more turning force and is harder to stall. See what happens now when you beat the propeller against a sheet of paper. Also notice that the propeller doesn't blow much air as a fan; it isn't pushing enough air because it is going slower.



Keep in mind the following:

- Gears change speed and torque.
- If speed decreases, torque increases.
- If speed increases, torque decreases.

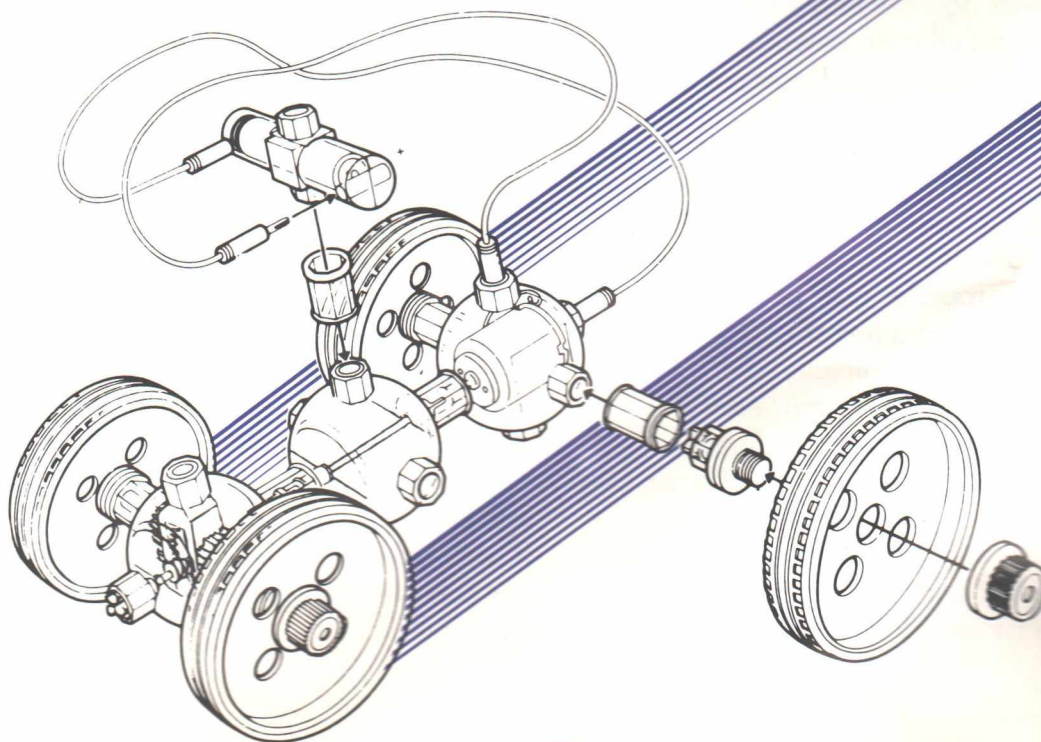
You can see this same effect with a car or bicycle gears. In 1st gear a car has lots of torque and can climb hills, but it can't go fast. In 3rd or 4th gear the car can go fast, but would stall on a steep hill.

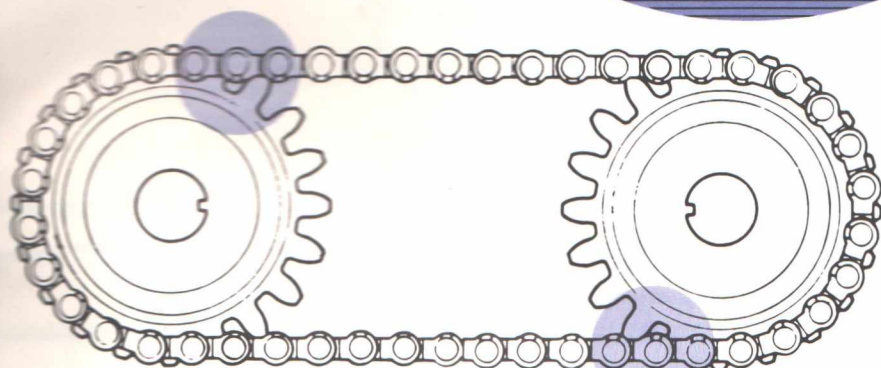
FRICITION AND TRACTION



We usually think of friction as something bad. It slows down wheels and uses up energy. However, we would have a hard time getting along without friction. Have you ever tried to walk on wet ice?

Friction provides the traction for our wheels. It allows the rubber tread to shove against the road. You can see the effect of this with the Capsela car. Take the rubber tires off the wheels and run the car on a smooth surface that can be tilted. How steep a hill can the car climb? Now put the tires back on and see how steep the hill can be before the car starts to slip.



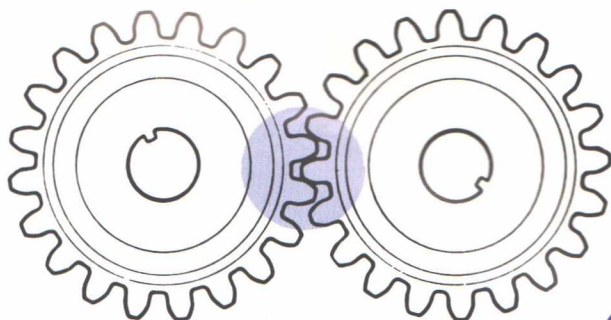


Bikes have gears. There's a large one fastened to the pedals, and at least one other on the hub of the back wheel. But they don't mesh—that is, the gears don't touch each other. Nevertheless, they are fastened to each other by the chain.

Examine the Capsela chain when it is linked around the toothed wheels. Every time a link slips onto a top tooth of one of the gears, another link slips off a bottom tooth of that gear. Also, every time a link slips off one of the gears, another link slips on the other gear. If the gears were the same size and had the same number of teeth, they would have to go at the same speed. However, suppose one gear has 10 teeth and the other has only 5. When the first one goes around once, it passes 10 chain links. That makes the smaller gear turn around twice, because it takes only 5 links to make the smaller one go around once.

A chain links gears so that they operate as if they were actually meshed together. The gear with 5 teeth goes around twice as fast as the gear with 10 teeth. As usual, however, you don't get something for nothing! The turning force, or *torque*, of the smaller gear is less than that of the big gear.

- larger gear, more teeth—lower speed—higher torque
- smaller gear, fewer teeth—higher speed—lower torque



Why use a chain drive instead of just putting the gears next to each other? The chain allows you to have the drive gear positioned at a distance away from the driven gear.



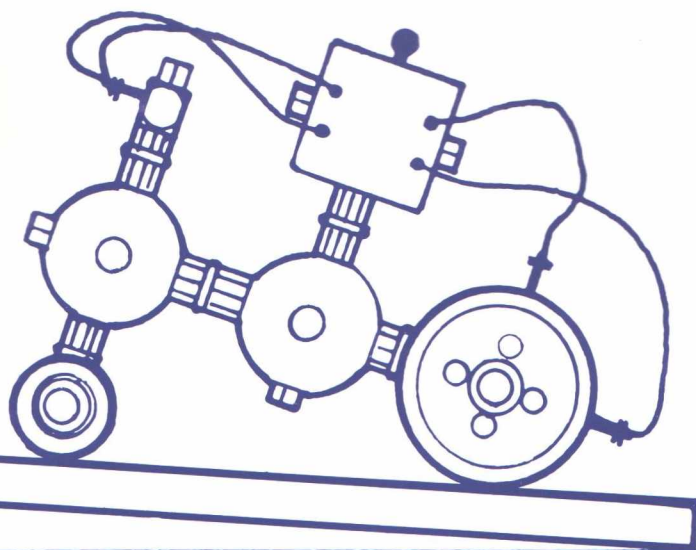
Work is the product of force exerted on an object and the distance the object moves in the direction of the force. If you push on a cart with a force of 10 pounds, and the cart moves 5 feet in the direction you are pushing, you have done 50 foot-pounds of work.

Simple machines, such as gears or levers or inclined planes, allow us to exchange force-exerted for distance-moved, or vice versa. But they do not save any work! On the contrary, because of friction it usually takes more work to do a job with a machine than without one.

With Capsela you can make an inclined plane to see why sometimes simple machines are useful or necessary. Get a long board, such as a book shelf, and prop up one end with one or more books. You can change the grade or the slope by adding more books. Find out how steep a slope the Capsela car or tractor can climb.

As the car climbs higher, it is gaining gravitational energy. To get to a particular height the car could be pulled straight up, or it could travel up along the inclined plane. The gentler the slope, the less force needed to move up. However, the gentler the slope, the further the car has to travel to reach the same height.

small force—large distance
large force—small distance



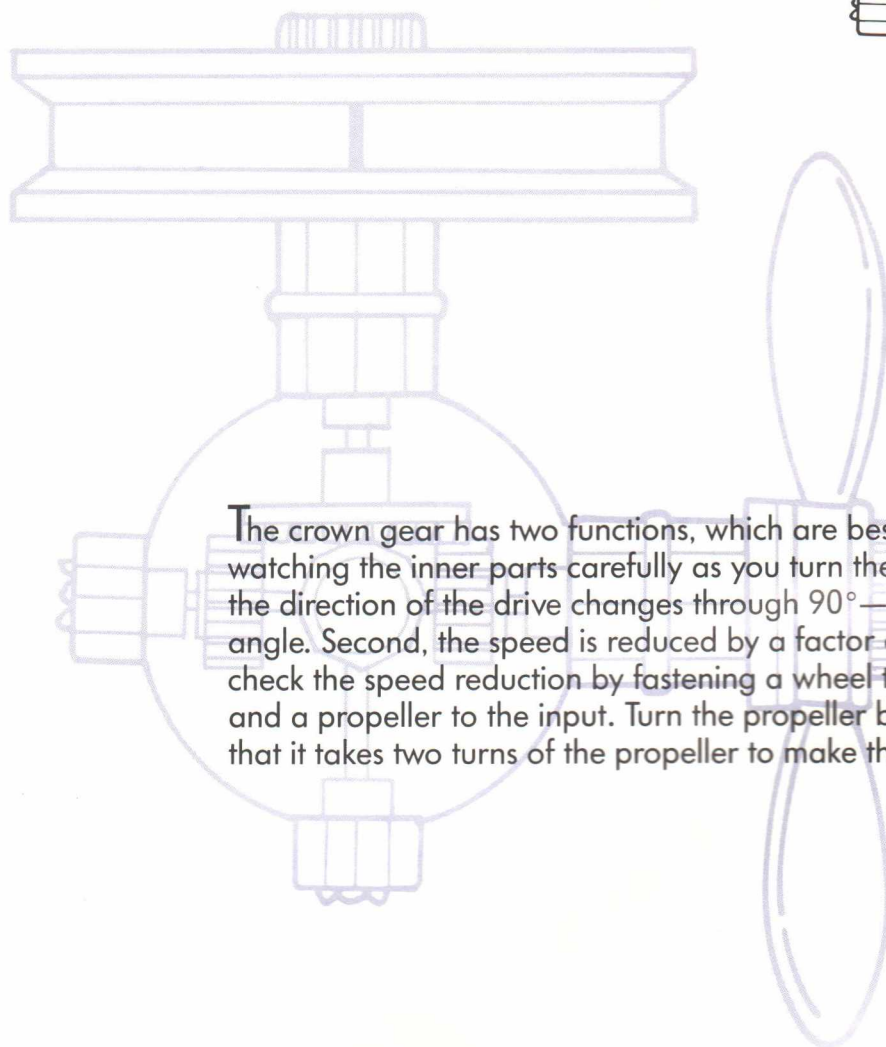
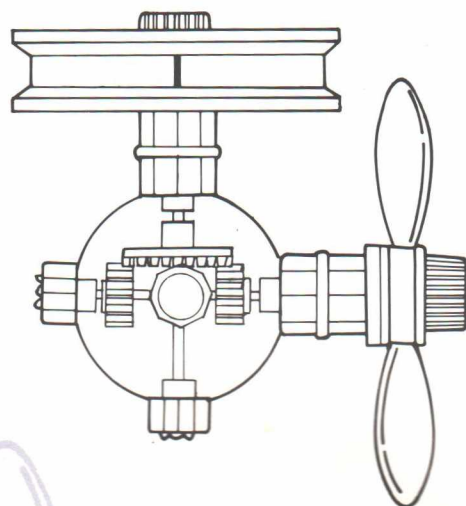
While you can't get something for nothing, there are times when it pays to sacrifice distance-moved for force-exerted. For instance, you might not be able to lift a 200 pound refrigerator 2 feet up onto a truck. But if you have a 10 foot board you can prop it between floor and truck. Then you can roll the refrigerator on caster wheels along the 10 feet, which also yields a rise of 2 feet. You might expect that the required force would be $\frac{2}{10}$ of the 200 pounds, or 40 pounds. Because of friction you would have to exert a force greater than 40 pounds, but it is usually still worthwhile. Work-in is equal to or greater (because of friction) than work-out.

$$(\text{greater than } 40 \text{ lbs}) \times (10 \text{ ft}) = (200 \text{ lbs}) \times (2 \text{ ft}) + \text{heat}$$

The extra work required by friction turns into heat.

P R O J E C T

THE CROWN GEAR

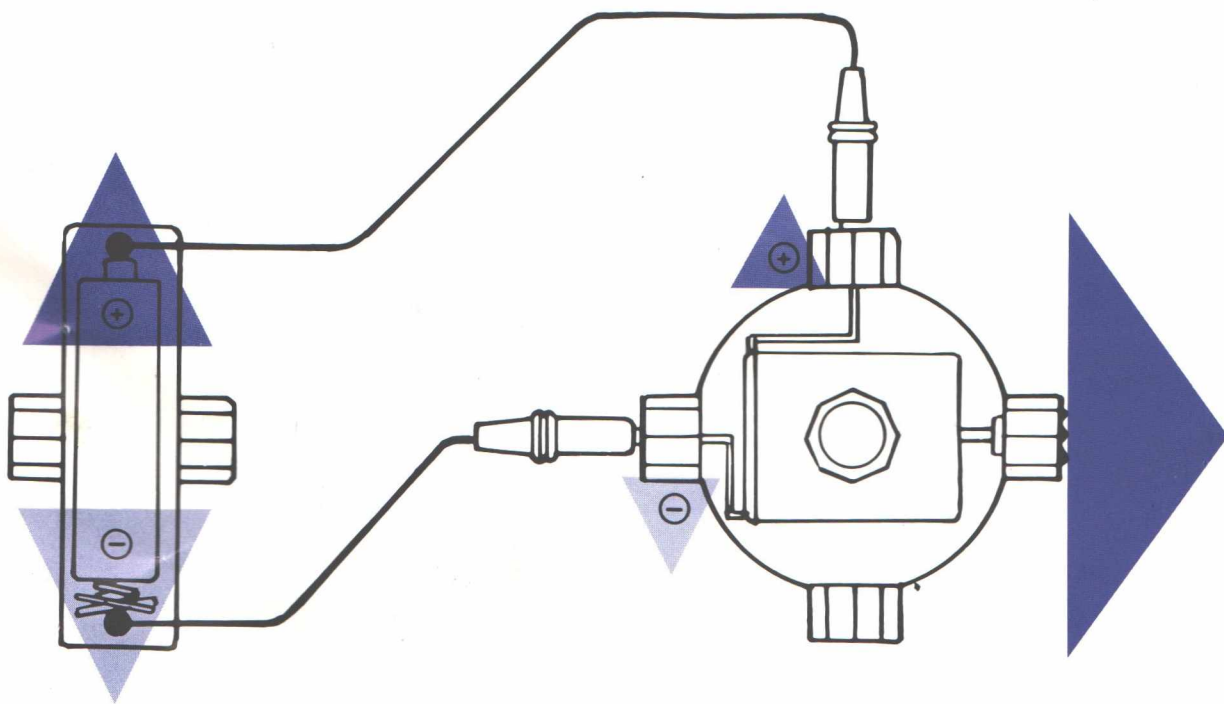


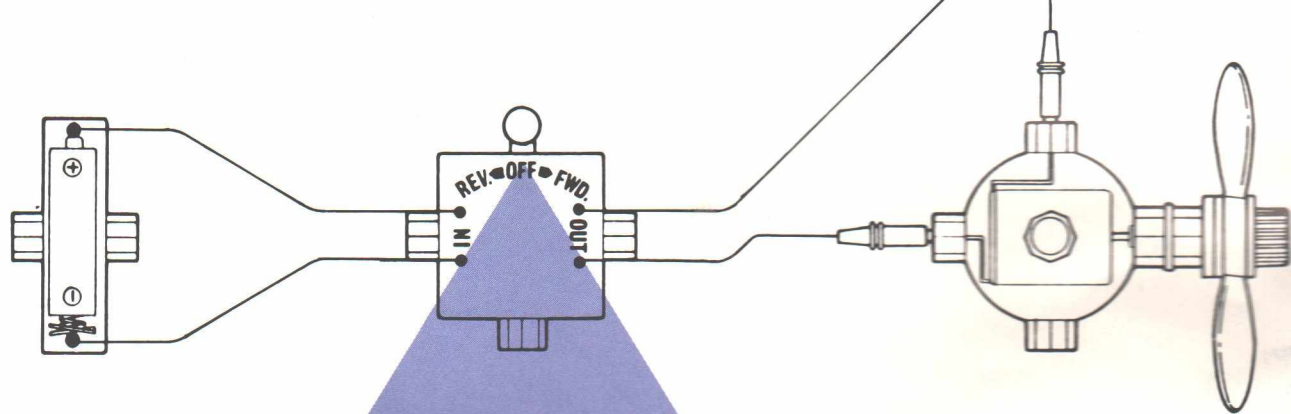
The crown gear has two functions, which are best understood by watching the inner parts carefully as you turn the gears slowly. First, the direction of the drive changes through 90° —through a right angle. Second, the speed is reduced by a factor of two. You can check the speed reduction by fastening a wheel to the output shaft and a propeller to the input. Turn the propeller by hand and notice that it takes two turns of the propeller to make the wheel turn once.

PROJECT

THE ELECTRICAL SWITCH BOX

You can explore the effect of the electrical switch by changing the direction of the current going through the motor and a lamp. First, use just the battery case and the lamp. Fasten the propeller to the motor so that you can see the direction of the motor. Connect the leads from battery to motor and note the direction that the motor turns. Now reverse the leads. Take the lead that was connected to the positive end of the battery and connect it to the negative end (-) and vice versa with the other lead. Observe that the motor reverses direction. Now try the same thing with the lamp. You won't see any difference. This ordinary kind of lamp doesn't care about the direction of the current.

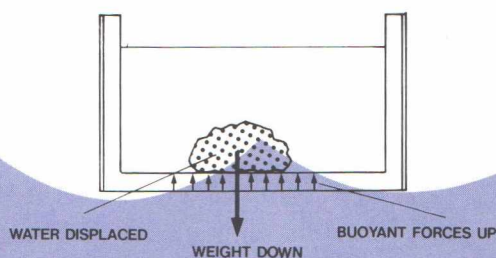
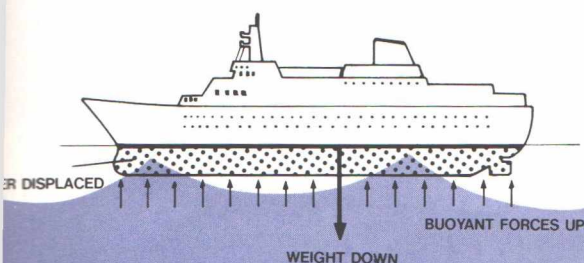




P R O J E C T

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BUOYANCY

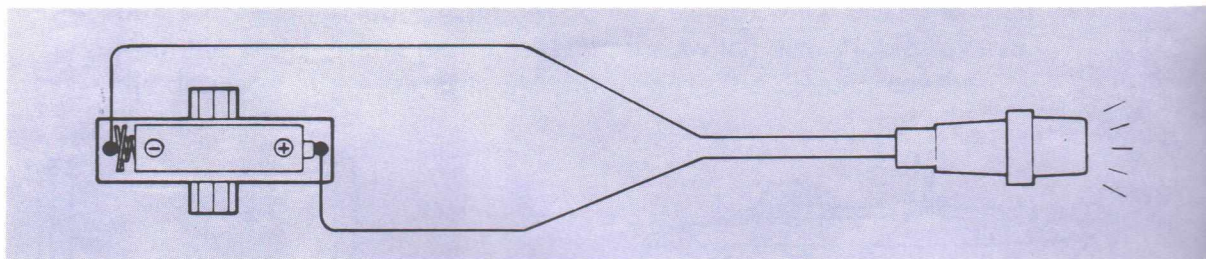


A solid object in a liquid experiences an upward *buoyant* force. The pronunciation of *buoyant* varies with locality, but sailors leave out the *u* completely. The buoy in a harbor is called a boy. People who don't live near the water may call it booe.

The law of buoyancy is called Archimedes' principle: An object in a fluid is buoyed up by a force equal to the weight of the *displaced* fluid. The *volume* of the displaced fluid is equal to the volume of the object.

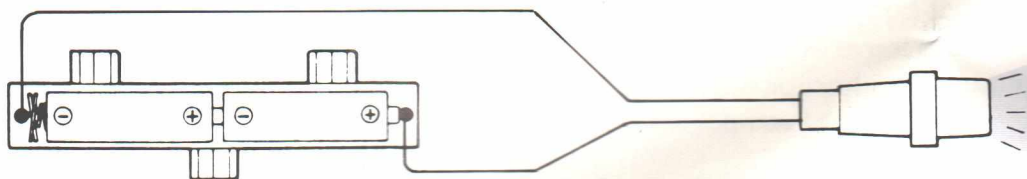
In order to see that water is displaced as an object is submerged, partially fill a jar with water. Choose a jar with a diameter not much larger than that of one of the yellow floats. Note first of all that the float does float and that it takes force to shove it under the water. As you shove it down, the water in the jar rises. By pushing the float down, you can feel the upward buoyant force. For understanding, it is far better to feel the buoyancy than to read about it!

ELECTRIC CIRCUITRY

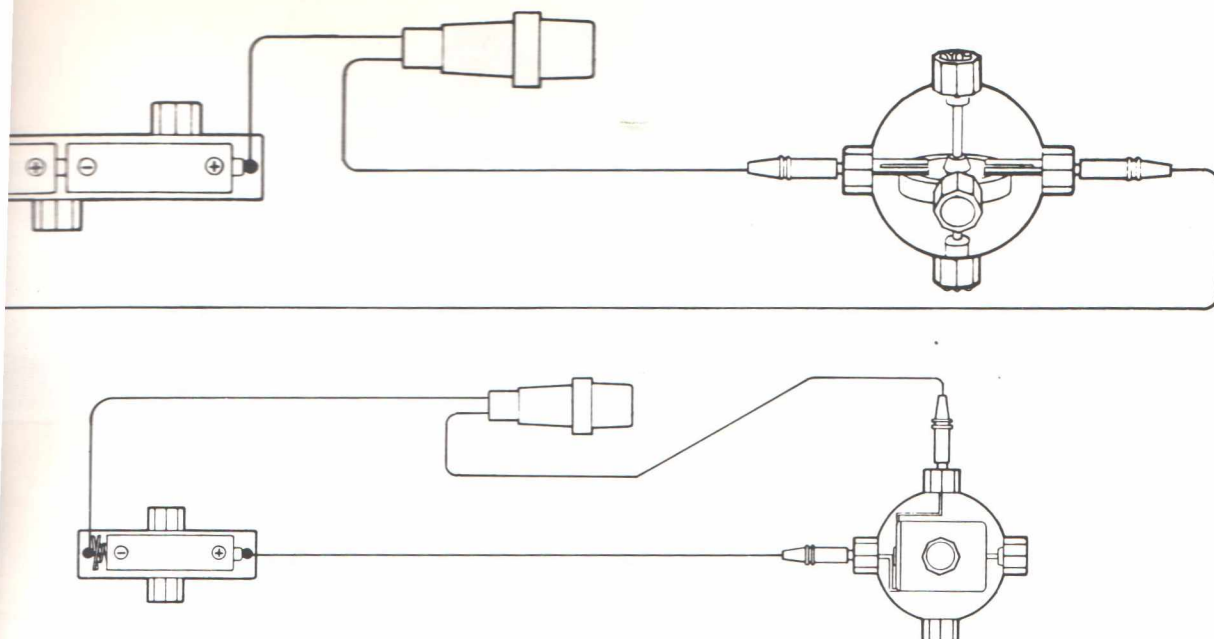


It is not always obvious how to connect wires and batteries in circuits. In this case, learning is best done by doing. You can explore circuitry by using the double battery holder and the rotary electrical switch capsule.

The “voltage” of a battery is a measure of the energy provided to each electric charge fed into the circuit. In series, the two $1\frac{1}{2}$ volt cells provide 3 volts. If they are connected plus to plus, instead of plus to minus, they provide $1\frac{1}{2} - 1\frac{1}{2} = 0$. Try reversing one of the cells in the double battery holder and observe that the unit will no longer light a bulb or run a motor.



Power the lamp with just one cell, which provides $1\frac{1}{2}$ volts and compare the brightness to that you get when you use the double cell and provide 3 volts. Try both combinations with the motor and see what happens to the power the motor can deliver.



Neither the lamp nor the motor present constant resistance to the current. You can see this effect with the motor (but not with the lamp) by wiring the lamp and motor in series. Watch what happens to the lamp as the motor first starts up, or if you begin to “stall” the motor by holding onto the drive shaft. The motor draws large current when it is moving slowly. You can see this effect, it makes the lamp get brighter. As the motor gets up to normal speed, it presents high resistance. Its high resistance dominates the series circuit so that low current is drawn and the bulb light is very dim.

Why should the motor draw low current when it is running fast? It doesn’t need much energy once it’s running! Therefore—or to use another explanation—the motor generates “back voltage” to reduce its input energy. When the motor starts up, when it is running gears and wheels, its resistance (back voltage) falls, it draws more current, and so transforms more energy. With this demonstration, you can actually “see” whether or not energy is being used.

You may be aware of a similar effect with house or car wiring. If a heavy motor starts up in a house, such as a water pump or air conditioner, the lights may *dim* for a moment. If you have your car lights on and start the engine, the lights may *dim*. This opposite effect is caused because the lights and motors are wired in *parallel*. When the motor draws high current in starting up, the voltage across both motor and lights is momentarily lowered. The motor, however, is drawing more current; a lamp in series with it would get brighter.

We have been using the word *circuit* as if it meant simply a “path” for the current. With the rotary switch you can actually see that the path must be an electrical conductor, usually copper metal. Wire the rotary switch in series with the lamp and a battery. Turn the rotary switch gear slowly by hand and watch what happens to the light when the switch is in different positions. Notice that the current cannot go through the blue plastic.

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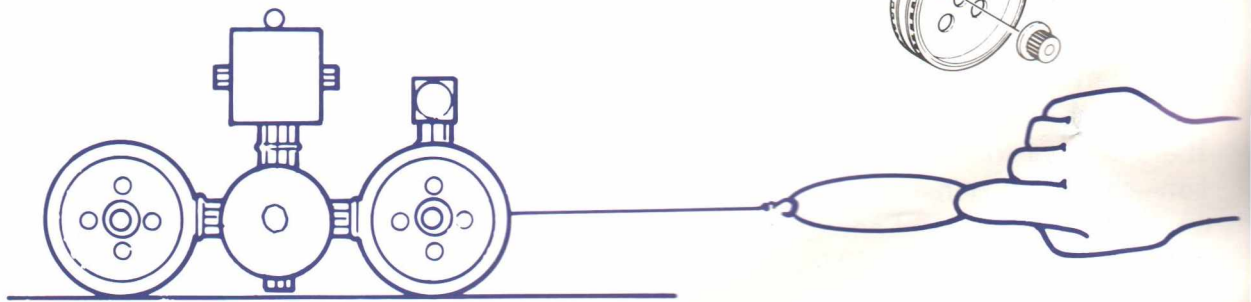
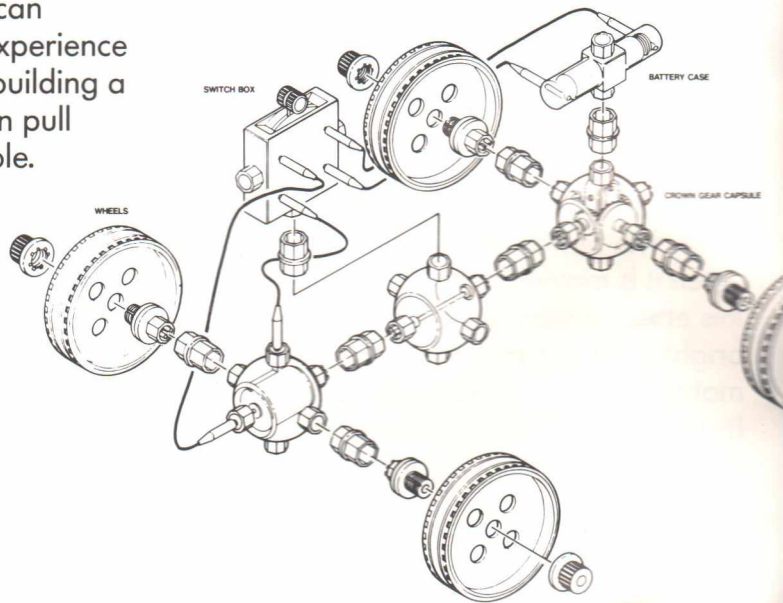
P R O J E C T

FORCE

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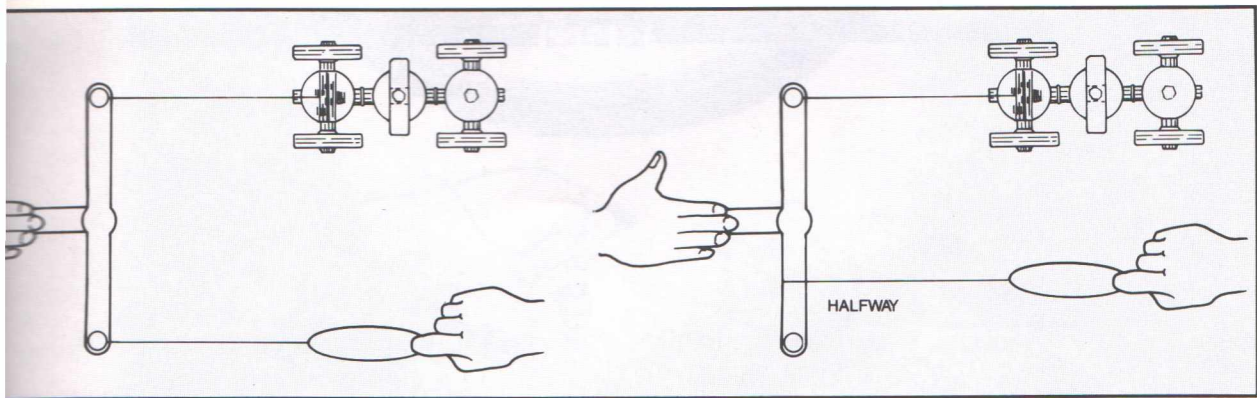
Force is a push or pull. In the English (now American) system of units, force is measured in pounds. In the metric (S.I.) units, force is measured in newtons. ($1 \text{ lb} = 4.5 \text{ N}$) In either case, you can understand force best if you experience it with your own muscles. Try building a Capsela car or tractor that can pull with as great a force as possible.

Remember, if you connect the motor directly to the wheels, the wheels will turn rapidly but with very small *torque*, or turning power. Also, in order for the car to have traction, it will have to have rubber treads on the wheels.

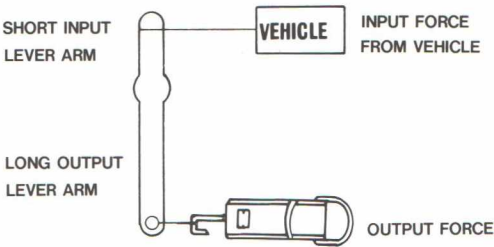


You can measure the force exerted by the car by seeing how steep a hill it can climb. The larger the force, the steeper the hill. You can also measure the force by hooking a rubber band at the back of the car and holding onto the other end of the

rubber band with your hand. You will feel the pull of the car as it stretches the rubber band. Furthermore, the stronger the force, the greater the stretch.



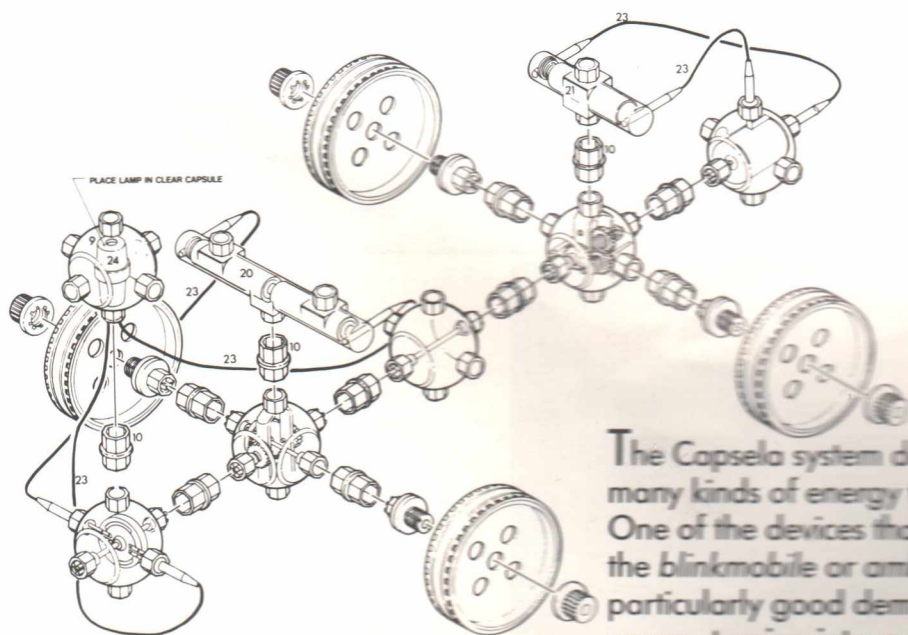
You can increase the force exerted by the Capsela car by using a simple machine—the lever. Fasten the *arm bar* to the *small bar connector* as shown in the diagram. The Capsela car can pull on one arm of the lever while your hand holds a rubber band fastened to the other arm. If the two lever arms are equal in length, the force exerted by the car is just equal to the force stretching the rubber band (and the force felt by your hand). If the input lever arm is twice the output lever arm, the output force (the force on the rubber band) will be twice the force exerted by the car. Even though the lever allows you to exert twice the force, you still can't get something for nothing! The car, fastened to the longer lever arm, has to travel twice as far as the output arm. Since the work done is equal to the product of force exerted and distance moved, the input work is still as large as the output work or even larger because of friction.



13

P R O J E C T

TRANSFORMATION OF ENERGY



The Capsela system demonstrates many kinds of energy transformations. One of the devices that you can build, the *blinkmobile* or *ambulance*, is a particularly good demonstration of energy turning into many different forms. The energy starts out stored in chemical binding energy in the battery.

When the electric circuit is complete, electric energy flows to the motor and turns into mechanical energy of motion and heat. If the car moves up an incline some of the energy becomes gravitational potential energy. Meanwhile, electric current in the lamp circuit turns into thermal energy of the lamp filament, making the bulb hotter and also giving off radiant energy of visible light.

14

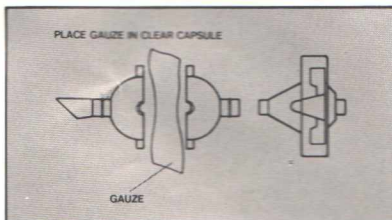
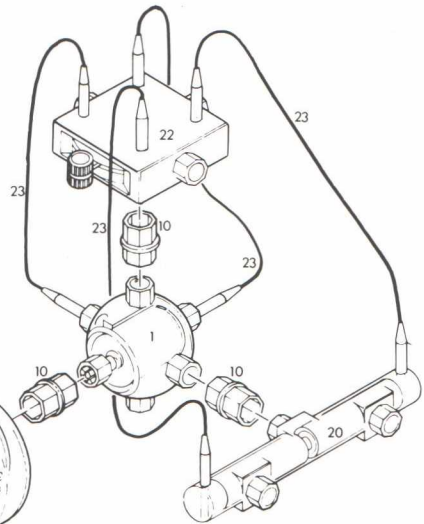
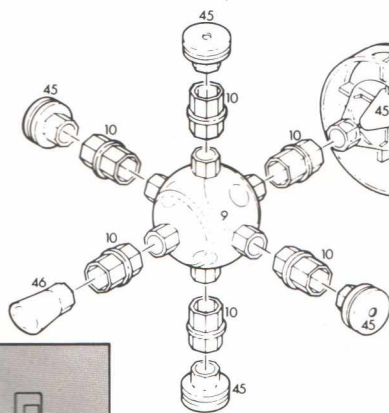
P R O J E C T

VACUUM



Vacuum means empty of everything—no air. Of course, a vacuum cleaner produces only a partial vacuum. The particular shrouded fan in the Capsela kit creates a breeze from input to output. That breeze is sufficient to draw dust into the chamber, and so, in effect, a partial vacuum is created.

You can create a larger partial vacuum by sucking on a straw. Liquid rises in a straw because the air pressure on the liquid surface forces the liquid up the straw when the partial vacuum is created inside.

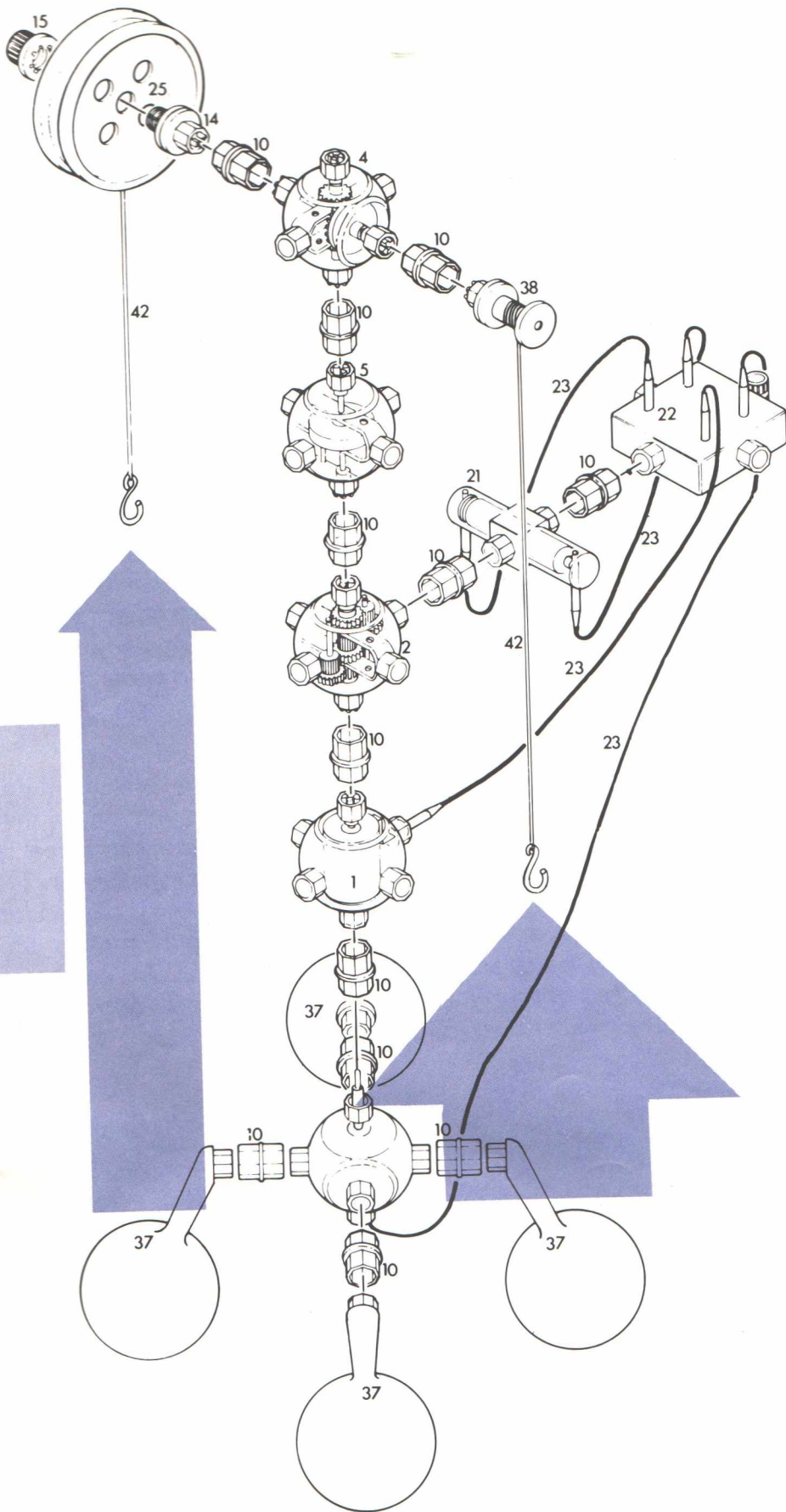




One of the simple machines is the *wheel-and-axle*. You make use of this machine when you build the *hoist*. Once again, with this machine you don't get something for nothing. The product of force and distance turned at the rim of the large wheel must be equal to the product of force and distance turned at the small axle. For instance, with a door knob, your hand exerts a small force through a considerable rotational distance in order to open the latch. At the axis, a large force is exerted to move the latch bolt, but the distance turned is small.

With the wheel-and-axle used with the Capsela hoist, the gears drive an axle that is common to two wheels. The large one raises objects rapidly, while the small one is very slow. But the small one can lift heavier loads.

15



16

P R O J E C T

NEWTON'S THIRD LAW

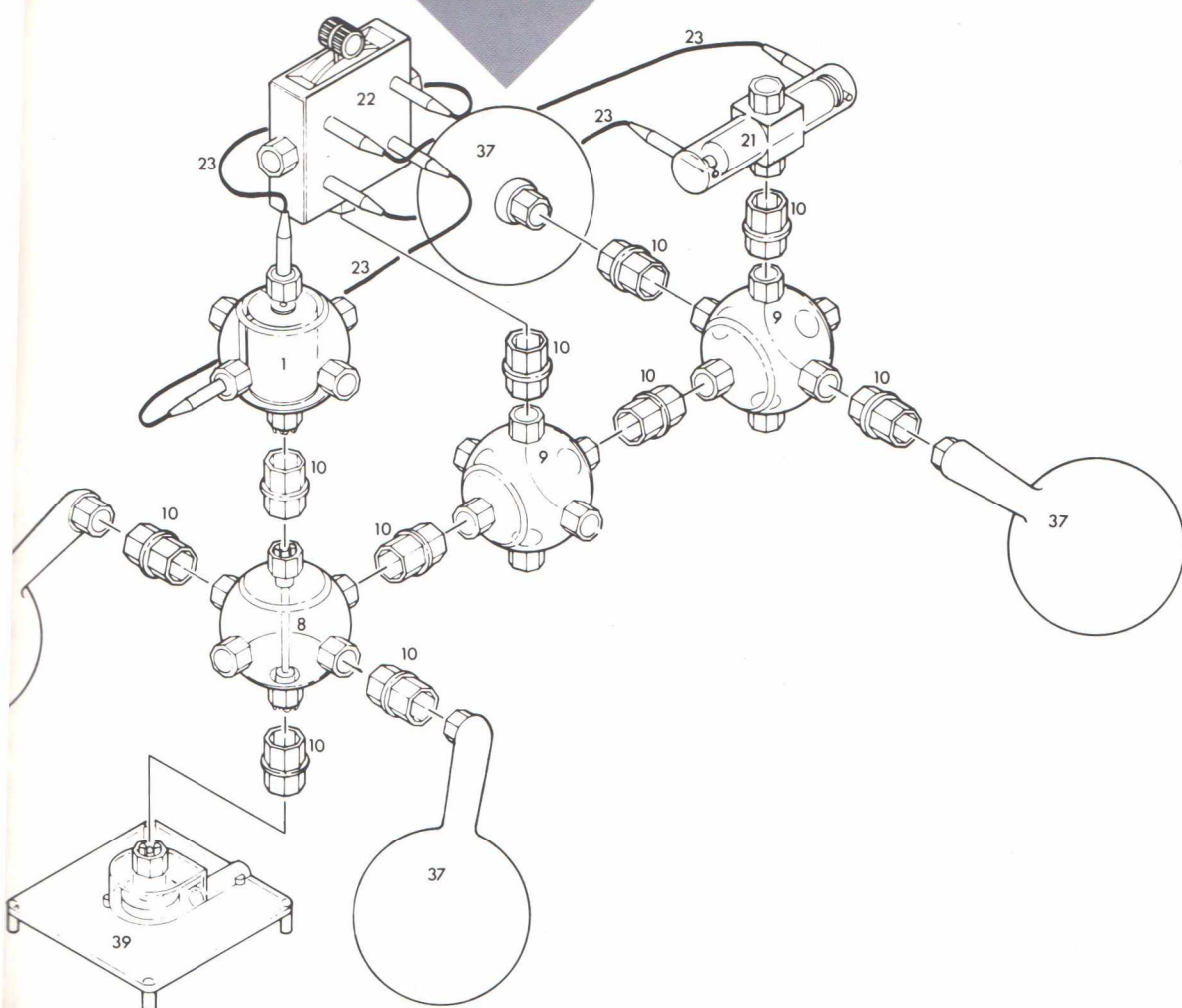


Newton's third law is usually expressed as, "To every action there is an equal and opposite reaction," Avoid these words if you can! Action and reaction are archaic words for this phenomenon, meaning something different in Newton's time than they do today. The word now is *force*. In any interaction between two objects, the force that the first exerts on the second is equal but opposite to the force that the second exerts on the first. The best way to understand this definition is to feel the effect in your hands.*

There are several Capsela devices that depend on Newton's third law for their operation. The effect is most obvious with any of the propulsion devices that shoot out air or water. For instance, feel the air blown away from the propeller in any of the propeller cars or boats. If the air is pushed backward, the car or boat is pushed forward. Reverse the direction of the air by reversing the motor with the switch, and the direction of the car or boat will also reverse. The same effect occurs when the propeller, or pump, or paddle wheel pushes water backward; the boat goes forward.

16

*Rockets don't need air to push against. In fact, the air gets in the way. As the high temperature, high pressure region inside a rocket expels the gases, the gases exert an equal force on the rocket in the opposite direction.



A particularly good example of Newton's third law can be produced by building the *hydrojet*. In this device, the water pump shoots water out, thus exerting an associated force on the pump in the opposite direction. You can change the direction of the water jet by fastening a short piece of tubing to the output of the pump. Bend the tubing so that the water jet shoots into the air. The boat will work just as well with the water shooting into air as it does with the water shooting under water. Furthermore, with this arrangement you can change the direction of the jet so that it shoots either backward, or forward, or sideways. See what happens to the boat under these several situations, and see how Newton's third law explains things every time!

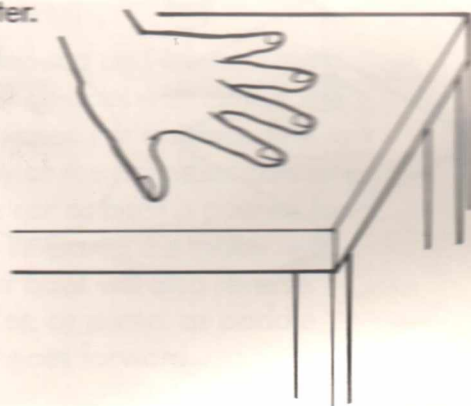
17

P R O J E C T

FRICTION



Most materials stick together, more or less. This is true of solids, liquids, and gases. Because of the sticking, it takes a force to move things past each other if they are touching. Because the force has to be continually exerted in the direction of motion, work is done. All the work used to overcome friction goes into heat energy. If an object already has motion energy, it will continually lose it to friction. The object slows down and the system gets hotter.



The Capsela machines slow down and stop when their energy sources are turned off, but it is not possible to detect the increase in temperature with your hands. However, everyone can feel how ordinary 60 watt light bulbs get hot when electricity goes through them. You can also feel what happens when solid objects rub against each other. For instance, your hands get warm when you rub them together. The head of a nail gets hot when you hammer it.

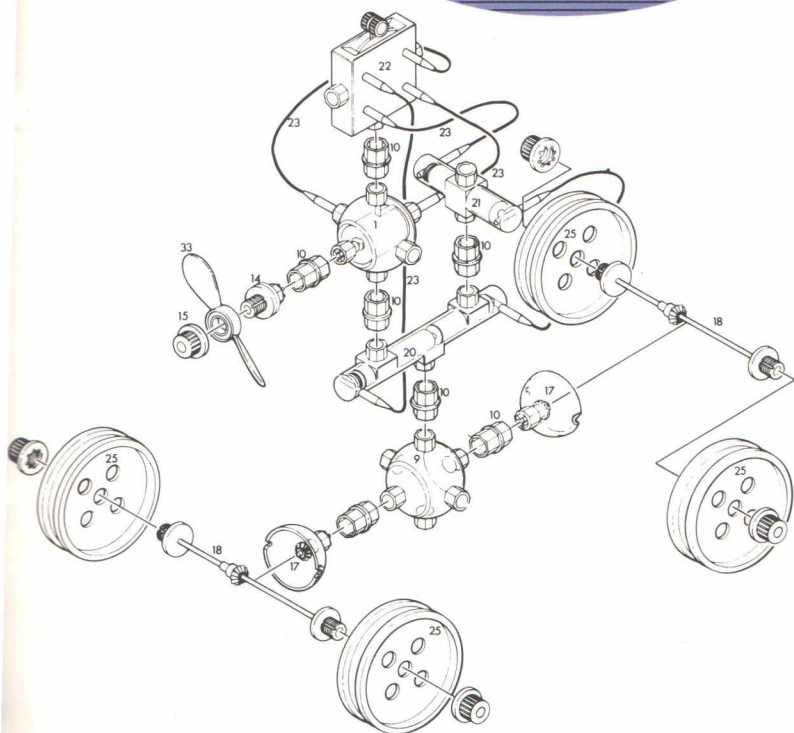
Of course, there is friction in the Capsela gears. Note that when you try to drive the speed-reduction capsule backwards, the motor may stall. It takes a lot of torque to overcome the friction, and the motor can't provide high torque.

It is not true that rough surfaces always create more friction than smooth surfaces. A flat board will often slide more easily on a rug than on another smooth board. Two pieces of clean, smooth, flat glass will not slide over each other easily at all. Friction is a complicated subject, but how could we walk without it?

18

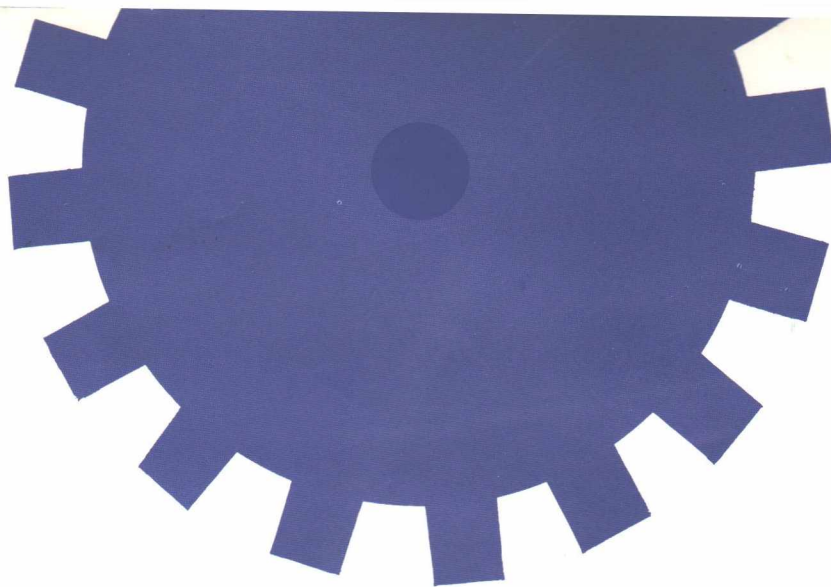
P R O J E C T

SCIENCE OF THE PROPELLER CAR

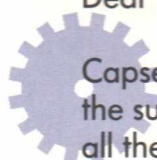


The propeller car amuses most people more than the air propeller boat or a car driven by its wheels. It's surprising to see wind used to propel a land vehicle. Furthermore, there are several interesting science phenomena to be seen with this device.

Use both battery cases, first wired to yield $1\frac{1}{2}$ volts, then 3 volts, and then $4\frac{1}{2}$ volts. This is a good exercise in circuitry. In each case, feel how much wind is being produced by the propeller and watch how fast the car moves. Once again, note that if the air is pushed backward, the car is pushed forward—or vice versa if you reverse the current direction with the switch. With only one battery powering the motor, only a little wind is produced and the car barely moves. With two batteries in series, the car moves easily, and with three batteries in series the propeller races, a large wind is produced, and the car moves rapidly.



Dear Capsela Fan,



Capsela is as limitless as your imagination. Once you have built all the suggested models you are ready to be your own inventor. Since all the Capsela parts are interchangeable from set to set you can design everything from a 5 capsule "lazer beamer" to a giant 6 foot "super robot" using over 150 capsules!

Add another dimension to your creations with the addition of Capsela's high-tech computer remote control systems, 2000 and 5000. You can program 17 functions including sound, light and move it in all directions and have it travel hundreds of feet plus input a computer memory with up to 94 commands.

If after experimenting you have any suggestions for Capsela models, projects or any comments in general we would like very much to hear from you.

Sincerely,
The Capsela Family





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